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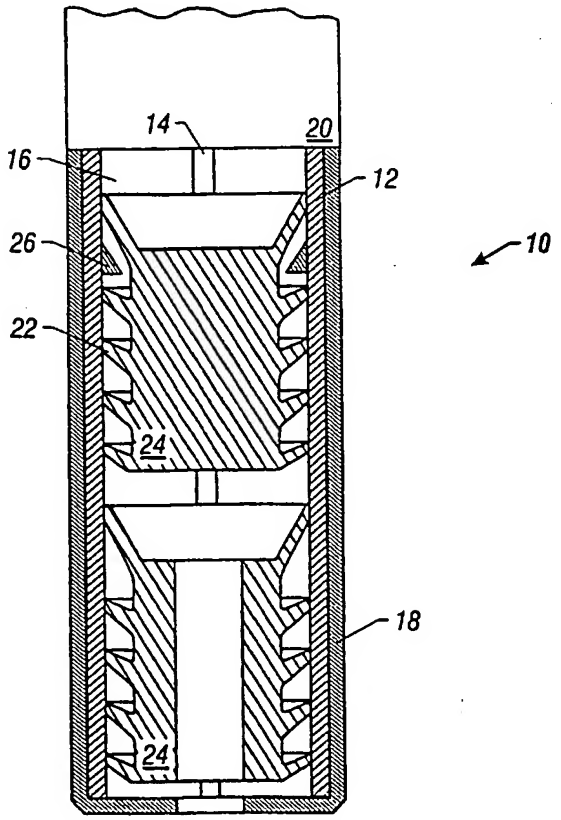
(54) Title: ANTI-ROTATION DEVICE FOR USE WITH WELL TOOLS



(57) Abstract: A drillable, anti-rotation device (10) for limiting the rotation of a downhole tool, such as a cement plug, when drilling out the down hole tool. The drillable, anti-rotation device comprises a drillable sleeve (12) connected within an outer tubular member connected within a pipe string. The sleeve (12) has one or more ribs (14) or other protrusions extending inwardly from the interior surface (16) of the sleeve (12) for gripping or otherwise retarding the rotation of such downhole tool.

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(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

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ANTI-ROTATION DEVICE FOR USE WITH WELL TOOLS

TECHNICAL FIELD

The present invention relates to drilling and exploitation techniques for downhole wells, and more particularly, but not exclusively, to drillable, anti-rotation devices for plugs, float collars and float shoes.

BACKGROUND

The process of drilling subterranean wells to recover oil and gas from reservoirs, consists of boring a hole in the earth down to the petroleum accumulation and installing pipe from the reservoir to the surface. Casing is the protective pipe liner within the wellbore that is cemented in place to insure a pressure-tight connection from the surface to the oil and gas reservoir. Casing is typically run into the hole in sections, cemented in place and drilling is continued below the casing until the reservoir is reached.

Typically, primary cementing is performed by running in a casing string into the wellbore. The casing string commonly has a float collar positioned one or two joints above the float shoe. Collars and shoes help prevent the back flow of cement during cementing operations. The collars and shoes are usually equipped with a check-valve to prevent cement from returning up the interior of the casing string. Once the casing is run to the desired depth, the casing remains filled with drilling fluid and the cementing operation may begin.

When it is desired to cement the casing in the wellbore, a bottom plug or wiper plug is launched in the casing between the fluid in the well and the cement slurry. This bottom plug commonly has a fluid passage through it which may be sealed by a diaphragm or membrane. The cement is pumped into the casing forcing the bottom plug down the well, displacing the fluid out of the well, until the bottom plug seats on the float collar, or shoe, or a shoulder. Once the plug reaches the restriction, pump pressure is increased rupturing the seal in the plug's fluid passage and the cement slurry flows through the plug and through the fluid passage of the shoe or collar. Once the required amount of cement is pumped into the well, a top plug is launched into the casing atop the cement column. Typically, the top plug does not have a fluid passage through it. A fluid is then pumped into the casing, forcing the top plug and the cement down the hole and up

the annulus between the casing and the wellbore. It should be recognized that one or more plugs may be utilized in cementing operations.

The plugs are usually constructed of a pliable or rubbery material, such as plastic, wood, rubber, or aluminum, and commonly have a hollow metal or plastic core. The plugs traditionally also have wings and fit snugly within the casing string. All of the plugs are constructed of a drillable material. The plugs have three primary purposes: (1) to separate the wet cement slurry from the fluid it is displacing or the fluid which is being used to pump the cement slurry to the desired level; (2) to wipe off the inner surface of the pipe string as the plug travels down the hole; and (3) to aid in preventing back flow of the cement as the cement sets.

Once the cement has set up and other desired operations have been performed, the plug(s), collar, shoes, and cement may be drilled out. In order to drill the well out, the drill string is run back into the hole until the drill contacts the top plug and the string and drill bit are rotated. In all too many instances when the drill bit is rotated, the plug begins to rotate atop of the plug, cement, collar, or shoe on which it rests. This rotation of the plug wastes valuable time and energy in attempting to drill out the plug.

Attempts in the past have been made to prevent the rotation of the plug(s) to aid in the drilling of the plugs. One device is disclosed in U.S. patent 5,842,517 and assigned to Davis-Lynch, Inc.. The '517 patent discloses a combination float collar, cement plug, and wiper plug each having inclined J-slots for interconnecting the pieces.

U.S. patent 5,390,736 assigned to Weatherford/Lamb, Inc., discloses interconnectable plugs and float collars having a "bunt" design. The '736 teaches forming a male "bunt" shaped end and female "bunt" end for fitting the male end.

U.S. patent 5,165,474 assigned to Dowell Schlumberger, discloses an anti-rotation device for plugs having deformable lips. The '474 teaches a tubular section having a high coefficient of friction and a divergent internal diameter.

U.S. patent 5,095,980 assigned to Halliburton Company, discloses a combination non-rotating plug set. The '980 patent teaches a combination of plugs and a collar having molded inserts or teeth. The teeth are adapted to interconnect when the individual tools are in contact to prevent rotation of the interconnected pieces.

U.S. patent 4,190,111 to Davis discloses an anti-rotation tool to be used in combination with a plug. The '111 teaches a flat plate having protrusions on both faces of the plate. The protrusions are designed to engage, dent and penetrate a cement surface on the plug. The plate is run below the wiper plug.

To date these prior art anti-rotation devices have failed to consistently and effectively prevent the rotation of the plugs when drilling out. In many cases at least one if not all the engaging surfaces fail to engage, allowing rotation of the plugs. In addition, it is not uncommon to fail to pump the plugs in contact with one another, preventing interconnection of the plugs. Further, in deviated or horizontal wells it is difficult, at best, to interconnect the tools to be drilled out, thereby resulting in failure to limit rotation of the plug. Additionally, it is common for the teeth, slots, hooks, protrusions to slip or fail negating the purpose of the devices. Further, the prior art devices require the purchase of interconnecting pieces, such as, a set of plugs and a corresponding shoe or collar from the same vendor, thereby limiting the choice of an operator to select preferred plugs, collars, and shoes.

It would be a benefit therefor, to have an anti-rotation device which is reliable and inexpensive. It would be a further benefit to have an anti-rotation device which does not require interconnection of the plugs to prevent rotation. It would be a still further benefit which does not require interconnection between the plugs and shoe or collar. It would be an additionally benefit to have an anti-rotation device which is adapted for use in deviated and horizontal wells. It would be a still further benefit to have an anti-rotation device which may be used with collars, shoes, and plugs originating from differing sources.

The present invention is a anti-rotational device of the type used for limiting the rotation of plugs when being drilled out is provided. The anti-rotational device includes: a sleeve connectable within a pipe string, the sleeve having at least one rib or other protrusion formed within the interior of the sleeve, the sleeve formed to dispose at least one plug therein limiting the rotation of the plug when drilling out.

The sleeve is a tubular member forming a passageway therethrough. The sleeve may be formed of any type of drillable material such as pliable rubbers and plastics, wood, aluminum, brass and the like. Many of these materials are currently used in drillable tools such as the plugs. Formed along the interior of the surfaces of the sleeve are protrusions such as ribs. These ribs

may be formed substantially along the longitudinal axis of the sleeve, or they may be formed in a substantially circumferential pattern, or at an angle to the longitudinal axis of the sleeve. In the substantially longitudinal projection the ribs or other protrusion act as a brake against the rotation of the plugs. In a slanted or "threaded" configuration, the ribs or other protrusion can be arranged so as to counteract the downward force and rotation of the drill bit and string and tend to force the plug upwardly against the bit, and counter to the rotation of the bit thereby aiding in the drilling of the plug, or to substantially thread the plug down to the bottom of the float collar or shoe to aide in drilling the plugs out. The rib(s) or other protrusion may have a substantially semi-circular, pseudo-circular, rectangular, triangular, or other profile which will aide in gripping the plugs and preventing rotation of the plugs.

The sleeve may be formed by molding within a piece of material such as collar stock, a pup joint, casing joint or other material. Additionally, the sleeve may be formed so as to be insertable into material available at the well site, such as a joint of casing. In this instant the sleeve can be adhered to the interior of the joint using commonly known adhesives. Additionally, the sleeve may have threads formed on the exterior thereof for threading into a housing or outer member such as casing or collar stock. This second embodiment more readily allows the anti-rotational device be adjusted to conditions and situations which may be encountered on-site.

The sleeve, whether molded or inserted into a member, may be connected directly to a float collar, shoe, or within a joint not directly adjacent to the shoe or collar. Examples of the anti-rotation device are: a pup joint for connecting where desired; an inline centralizer having an anti-rotation device; a float collar having the anti-rotation device formed therefrom; a float shoe having the anti-rotation device formed therefrom; various length pup joints for multiple plugs; and the sleeve anti-rotational device being formed as an insert which for example may be threaded into or adhered in a conduit such as collar stock or a joint of pipe. It should be recognized that the anti-rotation device can be made and altered on-site to accommodate various desired lengths such as for one plug, two plug, or multiple plug operations. Additionally, the anti-rotation device of the present invention may be used with plugs manufactured by one vendor and shoes and collars manufactured by another vendor.

In an alternative method, the anti-rotation device may be disposed within the casing string well away from a shoe or collar to provide an indication of the location of a plug as it is being

pumped down hole. The location can be determined from the spike in pump pressure when the plug encounters and passes through the anti-rotation device.

In use the anti-rotation device is placed in the casing string, typically by threading the outer member containing the sleeve into the pipe string. The operator may choose whether the anti-rotation device be pre-molded in a carrier or as an insert depending on the location. Additionally, the length of the anti-rotation device may be preselected or adjusted by selecting pups or interconnecting pieces. The inside diameter of the anti-rotation device is selected so that when drilled out the inside diameter of the casing string remains substantially the same as that of the adjacent pipe string. The ribs extend outwardly so as to compress a portion of the wings or lips of the plug. The wings may be deflected approximate their maximum deflection limits which is disclosed in plug vendor's specifications.

When the plug is launched into the casing string it is forced down hole by a fluid such as drilling mud or cement. When it reaches the anti-rotation device of the present invention the circumferential wings of the plug are deflected by the ribs of the sleeve lodging the plug within the sleeve. It is necessary, in particular for the bottom plug, that the force and pressure necessary to lodge the plug into the anti-rotation device is not so great as to rupture the sealed fluid passage way. In addition, if more than one rib is formed along the interior of the sleeve the ribs are spaced at a distance such that the plug's wings substantially form a seal against the interior of the sleeve to limit back flow of fluid and in particular cement slurry.

If it is desired, a second, third or more plugs are run into the hole as is well known in the art and lodged into the anti-rotation device. It is not necessary that each of the plugs interconnect with each other or with the collar or shoe. The lack of necessity for the plugs or plug and collar or shoe to interconnect is especially beneficial in deviated or horizontal wells.

When it is desired to drill out the plugs, collar, shoe, and cement, the drill bit is run into the hole on the drill string. When the top plug is encountered, the bit is rotated traditionally to the right to cut up and destroy the obstructions within the casing. As the bit rotates the plugs tend to follow the rotation of the bit, resulting in failure to drill out the plugs or increased time and energy to drill out the plugs. With the anti-rotation device of the present invention the sleeve ribs or other protrusions grip the plug and limit the rotation of the plug allowing it to be drilled out. In a preferred embodiment, the ribs have a semi-circular or quarter-circular profile with the planar

side disposed against the rotation of the plug. This design provides gripping strength to the ribs and lateral strength to withstand the rotational forces. Additional embodiments, such as a triangular profile also provide strength against the rotational force. Additionally, as cement is pumped through the cement plug it sets up in the annulus formed between the deflected portion of the wings and the sleeve ribs, thereby providing additional anti-rotation forces at least against rotation of the cement plug.

BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature and objects of the present invention, reference should be had to the following detailed description, taken in conjunction with the accompanying drawings, in which like elements are given the same or analogous reference numbers and wherein:

Figure 1 is a partial, cross-sectional view of the anti-rotation device of the present invention.

Figure 2 is a partial, cross-sectional view of another embodiment of the anti-rotation device of the present invention.

Figure 3 is a top view of the anti-rotation device of the present invention.

Figure 4 is a top view of another embodiment of the anti-rotation device of the present invention.

Figure 5 is a 360 degree view of the interior surface of the anti-rotation device of the present invention.

Figure 6 is a 360 degree view of another embodiment of the interior surface of the anti-rotation device of the present invention.

DESCRIPTION

Figure 1 is a partial, cross-sectional view of the anti-rotation device, generally designated by the numeral 10, of the present invention. Device 10 includes a drillable sleeve 12 having ribs 14 extending inwardly from the interior surface 16 of sleeve 12. Sleeve 12 and ribs 14 are made of a drillable material such as, but not limited to, pliable rubbers and plastics, wood, aluminum, and brass.

As shown in Figure 1, sleeve 12 is formed of plastic molded within a float shoe 18, however, float shoe 18 may be a pup joint, joint of pipe, collar stock or any other tubular which may be connected within casing string 20. Although not shown in Figure 1, sleeve 12 may be formed as a unitary structure which may be inserted and adhered to structure 18, or may have external threads formed thereon for threading into structure 18.

Sleeve 12 forms at least one rib 14 extending inwardly from interior surface 16 so as to deform the wings 22 of plugs 24 so as to lodge plugs 24 within sleeve 12 and to limit the rotation of plugs 24 when drilling out. The number and positioning of rib(s) 14 may vary depending on the inside diameter of the pipe and design considerations.

Additionally, anti-rotation device 10 may include a lock down device 26 such as the reducing diameter tabs shown in Figure 1. Lock down device 26 allows plugs 24 to pass downwardly and prevent the downhole pressure from urging plugs 24 out of sleeve 12 and back up the pipe string.

Figure 2 is another embodiment of anti-rotation device 10 of the present invention. Figure 2 shows an additional embodiment of a lock down device 26'. Lock down device 26' of this embodiment is a ring having a divergent diameter to allow plugs 24 to pass downhole and preventing back pressure from moving plugs 24 back up the pipe string. It should be recognized that lock down device 26' is not a required feature of device 10. It should further be recognized that lock down device 26' may be separate from sleeve 12 and attached within tubular 18.

Figure 3 is a top view of anti-rotation device 10. As shown, sleeve 12 is attached within tubular 18, with plugs 24 wedged into sleeve 12 and deformed by ribs 14. A small annulus may be formed between sleeve 12 and plugs 24. Annulus 24 may be plugged with cement (not shown) which aides in limiting the rotation of plugs 24 when being drilled out.

As shown in Figure 3, ribs 14 are substantially triangularly shaped having a planar side 30 and an elongated side 32. Preferably, planar side 30 is oriented so as to counter the rotation of

the drill bit and the rotation of plugs 24. Typically, drill bits rotate to the right. Elongated side 32 provides strength in limiting the rotation of plugs 24.

Figure 4 is a top view of another embodiment of anti-rotation device 10. As shown, sleeve 12 is formed of as a unitary piece to be inserted within a tubular 18 (not shown). Additionally, Figure 4 shows a semi-circular rib 14' as one of many configurations possible for ribs 14. As shown, rib 14' has a planar side 30' oriented against the rotation of plugs 24 (not shown) and a curved side 34.

Figure 5 is a 360 degree view of interior surface 16 of anti-rotation device 10 of the present invention. As shown in Figure 5, ribs 14 extend substantially longitudinally along sleeve 12.

Figure 6 is a 360 degree view of another embodiment of interior surface 16 of anti-rotation device 10 of the present invention. As shown in Figure 6, ribs 14" are angled across sleeve 12. In this manner ribs may be angled so as to tend to rotate the plugs into contact with the drill bit counter to rotation of the bit aiding in the drilling of the plugs or to rotate the plugs towards into interconnecting contact (see Figure 1 and 2) and to the bottom of device 10 to aide in the drilling of plugs 24.

It is noted that the embodiments of the anti-rotation device described herein in detail for exemplary purposes is of course subject to many different variations in structure, design, application and methodology. Thus, the ribs or other protrusions may take the form of teeth, buttons, projections, flanges, lips, shoulders, bumps, warts, knobs, studs, spines, or the like, or combinations thereof extending inwardly from the interior surface of the one or more sleeves, and preferable, having at least one surface which is other than perpendicular to the longitudinal axis of the sleeve. Because many varying and different embodiments may be made within the scope of the inventive concepts herein taught, and because many modifications may be made in the embodiment herein detailed in accordance with the descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An anti-rotation device for limiting the rotation of a downhole tool disposed therein, said anti-rotational device comprising:

a drillable sleeve connected within an outer tubular member, said sleeve forming a passageway therethrough between first and second open ends, said outer tubular member connectable within a pipe string; and

at least one protrusion extending inwardly from the interior of said sleeve for gripping a tool disposed within said sleeve;

whereby said protrusion rotation of said gripped tool when said tool is being acted upon by a rotational force.

2. The anti-rotation device of **Claim 1**, wherein:

said at least one protrusion is oriented substantially along the longitudinal axis of said sleeve.

3. The anti-rotation device of **Claim 1**, wherein:

said at least one protrusion is oriented angled from the longitudinal axis of said sleeve, whereby said tool tends to rotate counter to the rotation of a cutting device.

4. The anti-rotation device of **Claim 2**, wherein:

said at least one protrusion has a pseudo-circular profile.

5. The anti-rotation device of **Claim 2**, wherein:

said at least one protrusion has a triangular profile.

6. The anti-rotation device of **Claim 2**, wherein:

said at least one protrusion has a rectangular profile.

7. The anti-rotation device of **Claim 3**, wherein:

said at least one protrusion has a pseudo-circular profile.

8. The anti-rotation device of **Claim 3**, wherein:
said at least one protrusion has a triangular profile.

9. The anti-rotation device of **Claim 3**, wherein:
said at least one protrusion has a rectangular profile.

10. An anti-rotation device for limiting the rotation of a downhole tool disposed therein, said anti-rotational device comprising:
a drillable sleeve connected within an outer tubular member, said sleeve forming a passageway therethrough between first and second open ends, said outer tubular member connectable within a pipe string; and
at least one protrusion extending inwardly from the interior of said sleeve for gripping a tool disposed within said sleeve, said at least one protrusion extending substantially along the longitudinal axis of said sleeve;
whereby said at least one protrusion limits rotation of said gripped tool when said tool is being acted upon by a rotational force.

11. The anti-rotation device of **Claim 10**, wherein:
said sleeve is molded within said outer tubular member.

12. The anti-rotation device of **Claim 11**, wherein:
said at least one protrusion has a pseudo-circular profile.

13. The anti-rotation device of **Claim 11**, wherein:
said at least one protrusion has a triangular profile.

14. The anti-rotation device of **Claim 11**, wherein:
said at least one protrusion has a rectangular profile.

15. The anti-rotation device of **Claim 10**, wherein:
said sleeve is inserted within said outer tubular member and secured therein by an adhesive.

16. The anti-rotation device of **Claim 15**, wherein:
said at least one protrusion has a pseudo-circular profile.

17. The anti-rotation device of **Claim 15**, wherein:
said at least one protrusion has a triangular profile.

18. The anti-rotation device of **Claim 15**, wherein:
said at least one protrusion has a rectangular profile.

19. The anti-rotation device of **Claim 10**, wherein:
said sleeve has threads formed on at least one portion of its exterior surface and is threadably connected within said outer tubular member.

20. The anti-rotation device of **Claim 19**, wherein:
said at least one protrusion has a pseudo-circular profile.

21. The anti-rotation device of **Claim 19**, wherein:
said at least one protrusion has a triangular profile.

22. The anti-rotation device of **Claim 19**, wherein:
said at least one protrusion has a rectangular profile.

23. An anti-rotation device for limiting the rotation of a downhole tool disposed therein, said anti-rotational device comprising:

a drillable sleeve connected within an outer tubular member, said sleeve forming a passageway therethrough between first and second open ends, said sleeve connectable within a pipe string; and

at least one rib extending inwardly from the interior of said sleeve for gripping a tool disposed within said sleeve, said at least one extending at an angle from the longitudinal axis of said sleeve;

whereby said at least one rib limits rotation of said gripped tool when said tool is being acted upon by a rotational force.

24. The anti-rotation device of **Claim 23**, wherein:

said sleeve is molded within said outer tubular member.

25. The anti-rotation device of **Claim 24**, wherein:

said at least one rib has a pseudo-circular profile.

26. The anti-rotation device of **Claim 24**, wherein:

said at least one rib has a triangular profile.

27. The anti-rotation device of **Claim 24**, wherein:

said at least one rib has a rectangular profile.

28. The anti-rotation device of **Claim 23**, wherein:

said sleeve is inserted within said outer tubular member and secured therein by an adhesive.

29. The anti-rotation device of **Claim 28**, wherein:

said at least one rib has a pseudo-circular profile.

30. The anti-rotation device of **Claim 28**, wherein:

said at least one rib has a triangular profile.

31. The anti-rotation device of **Claim 28**, wherein:
said at least one rib has a rectangular profile.

32. The anti-rotation device of **Claim 23**, wherein:
said sleeve has threads formed on at least one portion of its exterior surface and is threadably connected within an outer tubular member.

33. The anti-rotation device of **Claim 32**, wherein:
said at least one rib has a pseudo-circular profile.

34. The anti-rotation device of **Claim 32**, wherein:
said at least one rib has a triangular profile.

35. The anti-rotation device of **Claim 32**, wherein:
said at least one rib has a rectangular profile.

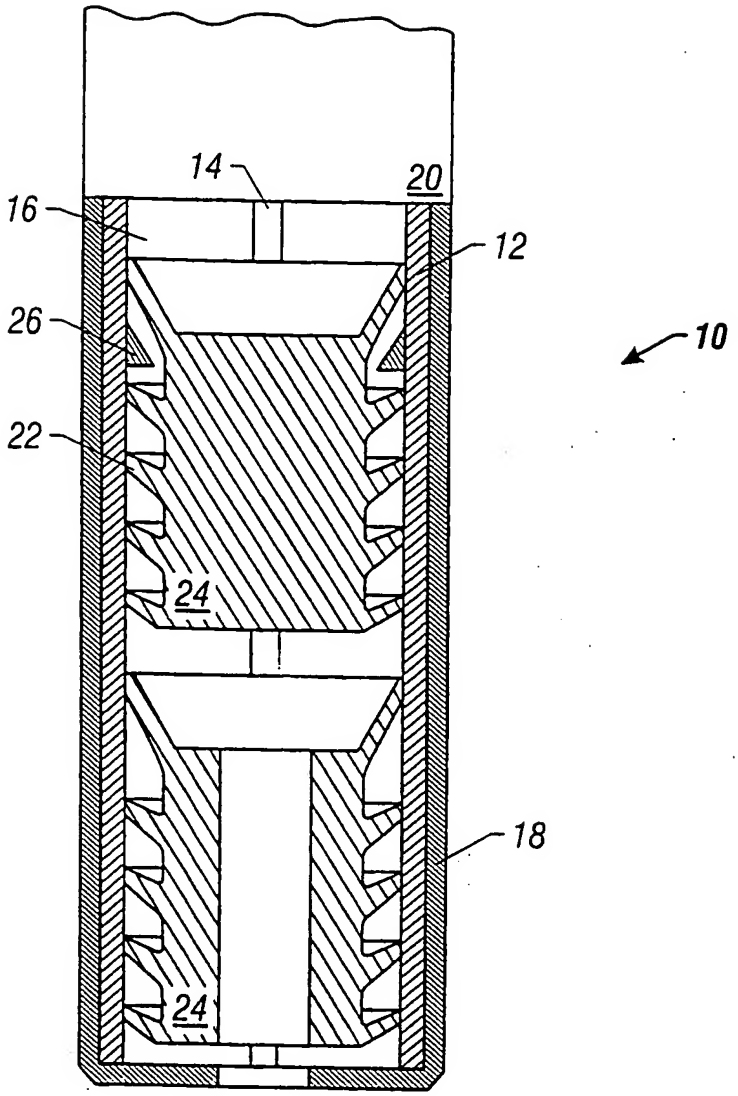

FIG. 1

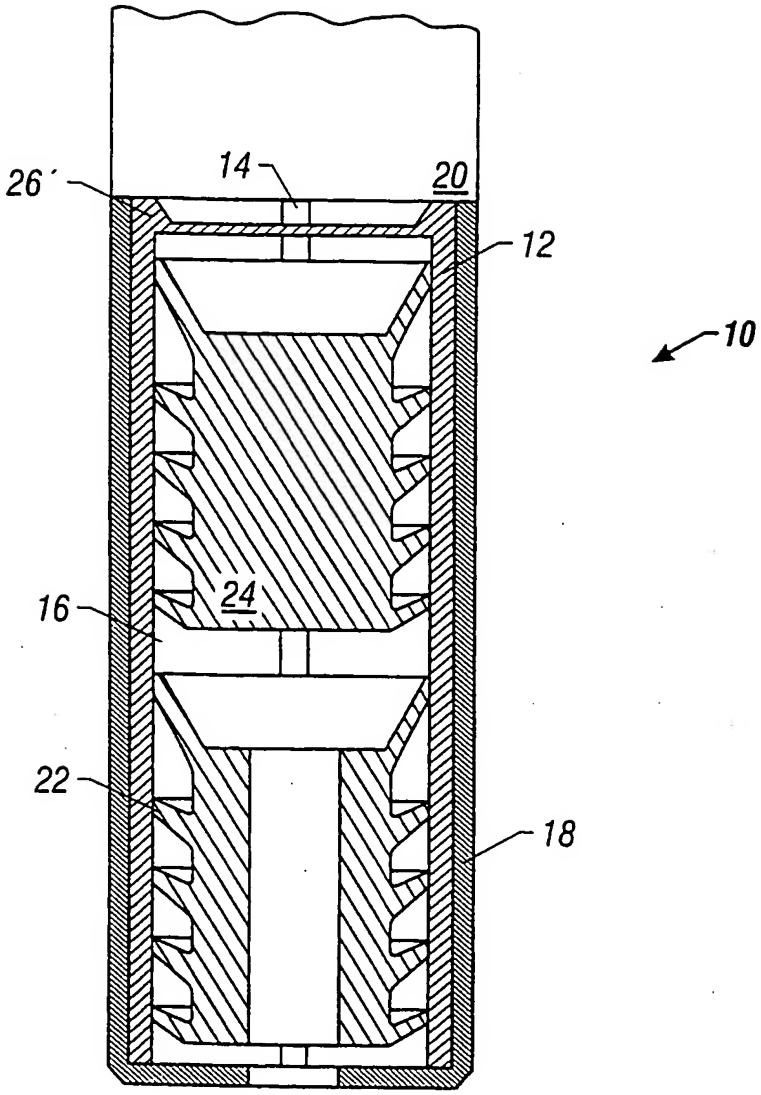

FIG. 2

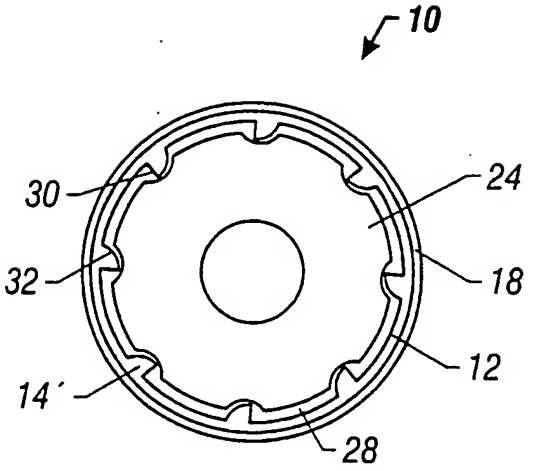

FIG.3

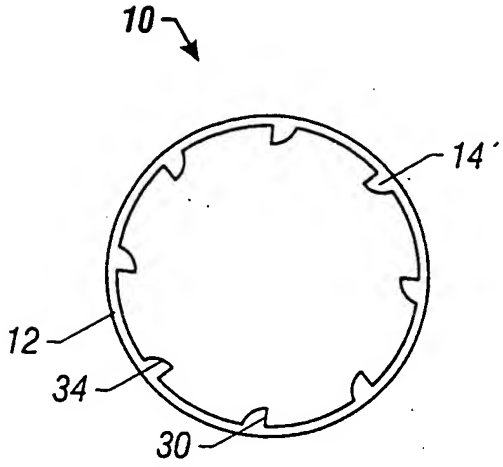

FIG.4

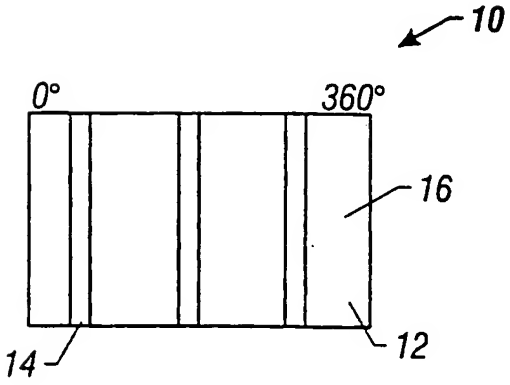

FIG.5

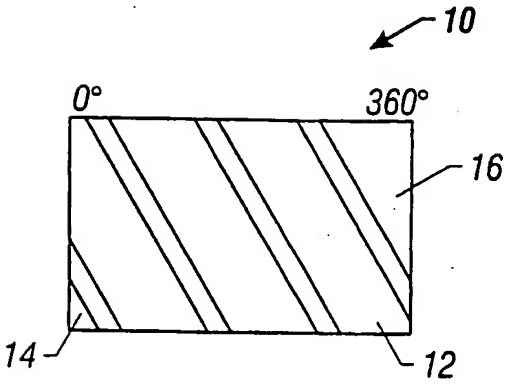

FIG.6

INTERNATIONAL SEARCH REPORT

Intemational application No.
PCT/US99/23861

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :E21B 23/00

US CL :166/117.7, 153, 156, 177.4, 242.1, 376

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/117.7, 153, 156, 177.4, 241.1, 242.1, 243, 376

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Please See Continuation of Second Sheet.	

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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"O"	document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search	Date of mailing of the international search report
09 DECEMBER 1999	08 FEB 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JENNIFER R. DOUGHERTY Telephone No. (703) 308-1113

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/23861

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,390,736 A (BUDDE) 21 February 1995 (21.02.95), column 1, lines 14-18, column 1, lines 65-66, column 2, lines 1-2, column 2, lines 65-69, column 3, lines 1-48, figure 2.	1, 2, 4, 10 ------ 3, 5-9, 11-35
Y	US 3,818,999 A (GARRETT) 25 June 1974 (25.06.74), figure 1, column 4, lines 35-40.	3-9, 23-35
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